ALBION
PLANT NUTRITION
Minerals • Science • Chelates

Plant Nutrition Newsletter

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CHEMICAL PROPERTIES OF CHELATES

by Jeremy O'Brien

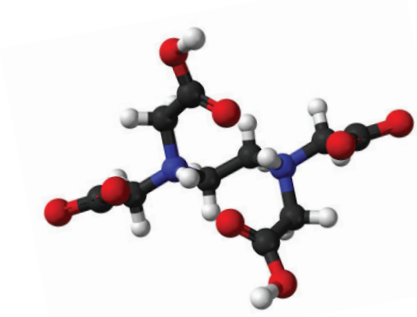
This is an excerpt taken from a paper presented by Robert B. Jeppsen, Ph.D. at Albion's® conference on plant nutrition in March, 2010.

"In agricultural settings, the term "chelate" has often been misunderstood or misapplied in a general or catch-all fashion. Although chelation is a defined chemical term, the molecules (known as ligands) which bind to the minerals may vary widely in their physical, chemical, and nutritional properties. For this reason, it is not sufficient to refer to a mineral nutrient as "a chelate," inferring that any one chelate is just like any other one. Among the different types of chelated molecules, nutritional quality depends on the choice of the ligands and the proper chemistry of making chelates. The proposed ligand (chelating agent) must have chemically reactive sites (moieties) capable of participating in the chelation process. The reactants must also be in the proper mole ratios for chemical combination to occur. There are additional considerations of spatial orientation. If the chelating moieties do not align properly for a feasible bond to form without straining the molecular structure, it will not form. If the ligand is too large, the probability of reactive moieties coming close enough for chelation to occur is remote.

Importance of bonding strengths on metal bioavailability from chelates

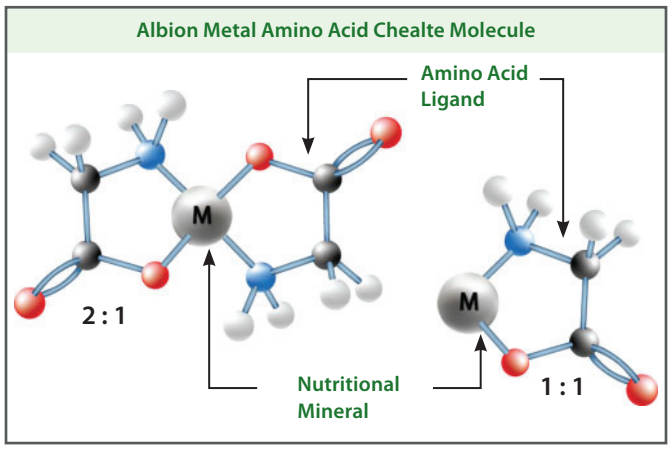
Any metal (mineral) chelate is a different molecule than either the metal or the ligand that have created it. The metal chelate will have its own unique properties. What is less understood is that there are a great number of different kinds of metal chelates possible because there are many different kinds of ligands. Different metal chelates of the same ligand will share similar properties, such as their relative degrees of bioavailability. Minerals having different ligands are much more segregated than different minerals, which share the same kind of ligand. This is because the properties of the ligand confer so much similarity on the chelates formed by it and different ligands have different chemical and physical properties. An example of a property of a chelated molecule that has great bearing on its nutritive capability is the strength of the actual bonds formed between the metal and the ligand. An early chelator that was used for mineral nutrition in plants was ethylenediaminetetraacetic acid (EDTA). The EDTA molecule forms bonds with metals that are very strong (having high stability constants). Plants (and other forms of life) find it difficult to free the metal atoms for metabolic usage. Thus, EDTA is often used as a sequestering agent for minerals sown into soil for slow release nutrition. Occasionally, EDTA chelated minerals are used as foliar nutrients, but their high stability decreases the release of their minerals at the plasma membrane. If some of the minerals are released at the plasma membrane, the strongly chelating EDTA scavenges calcium out of the cell walls of the leaves and contributes to leaking cytoplasm, cell damage, and disease.

EDTA Molecule



Albion, has demonstrated which relative strengths of bonds should be incorporated into Albion Metal Amino Acid Chelates to assure that the minerals contained in the chelates can be released to appropriate metabolites within the plant cells. Albion **Metalosate®** chelates are complete nutrients

since, upon cleavage, the needed metals are released and the residual cleaved ligands become normal amino acids that can then enter their normal metabolic pools. There are no xenobiotic ligands for the plant to attempt to metabolize, detoxify, or sequester to protect itself from toxic buildup—nor are xenobiotic toxins accumulated into the environment.



Advantages of Albion Metalosate Amino Acid Chelates

Advantages of using amino acids as the ligands for chelating nutritive metals include:

1. Easily absorbable small molecular size
2. Affinity of the ligands to basic metabolism (the ligands are not synthetic or foreign to living systems, but are actually required by them)
3. Since chelation occurs at the proximal sites of the carboxyl moiety and the α-amino nitrogen, each amino acid is capable of forming chelates in the same way because all of the ligands are α-amino acids and all of such chelates result in stable five-membered rings
4. Bonding strengths are strong enough for the molecules to remain intact through application and absorption, but not so strong as to resist breakdown for metabolic usage of the metal atoms
5. Reduction of charge on either the metal atom or the molecule, as a whole
6. Ease of passage of the chelate containing the mineral through the cuticle and cell wall barriers and into the cells of the plants

Chelates are characterized by the presence of coordinate covalent bonds. These occur when unbonded pairs of electrons on non-metal atoms like nitrogen and oxygen fill vacant d-orbitals in the metal atom being chelated. Valence positive charges on the metal atom can be balanced by the negative charges of combining amino acid ligands. The bonding of an electron pair into vacant orbitals of the metal allows for more covalent bonding than the valence (or oxidation number) of the metal would indicate. Forming bonds this way is called coordination chemistry. This allows chelates to form, providing that the ligands can bond with two or more moieties within the same molecule and providing that proper chemistry promoting chelation is present."

This passage illustrates the complex chemistry that is involved in forming chelates in general and more specifically amino acid chelates. It is obvious that all chelates are not equal and each has its place in science and nutrition. It is important to understand that just because a product contains amino acids does not mean that it is a true amino acid chelate. For more information on the Metalosate products please contact your local Albion Plant Nutrition representative.

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